SILICA AEROGEL: AN INTRINSICALLY LOW DIELECTRIC CONSTANT MATERIAL*

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Abstract:

Silica aerogels are highly porous solids having unique morphology amongst materials because both the pores and particles making up the material have sizes less than wavelengths of visible light. Such fine microstructure modifies the normal transport mechanisms within aerogels and endows them with a variety of exceptional physical properties. For example, aerogels have the lowest measured thermal conductivity and dielectric constant for any solid material. The low dielectric properties of silica aerogels are intrinsically the direct result of the extremely high achievable porosities, which are controllable over a range from 75% to more than 99.8%, and which result in measured dielectric constants from 2.0 to less than 1.01. In this presentation, the synthesis of silica aerogels, processing them as thin films, and characterizing their dielectric properties will be discussed. Existing data and other physical characteristics of bulk aerogels (e.g., thermal and chemical stablity, thermal expansion, moisture absorption, modulus, dielectric strength, etc.) which are useful for evaluating them as potential dielectrics for microelectronics, will also be presented.

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Such a unique morphology modifies the normal molecular transport mechanisms within the material, resulting in exceptional thermal, acoustical, mechanical, and electrical properties. For example, aerogels have the lowest measured thermal conductivity and dielectric constant for any solid material. In this paper, the synthesis of aerogel and characterization of the dielectric properties will be discussed.

we discuss methods of processing inorganic aerogel films having controllable thicknesses in the range 0.5 to 200 micrometers. We report methods and results of characterizing the films including thickness, refractive index, density, dielectric constant and thermal conductivity. We also discuss results of metallization and patterning on the aerogel films for applications involving microminiature electronics and thermal detectors.

OUTLINE

I. Introduction

II. Aerogel films on substrates
    A. processing requirements
    B. methods

III. Characterization
    A. thickness
    B. refractive index - density
    C. dielectric constant
    D. thermal conductivity
    E. optical

IV. Metallization and patterning methods

V. Applications

VI. Conclusions